# Background on Monitored Natural Attenuation

**This page has been left blank intentionally for printing purposes.**

# EPA Policy On Use of Monitored Natural Attenuation For Site Remediation

## Background on Directive

EPA's Office of Solid Waste and Emergency Response (OSWER) developed **Policy Directive:** ***Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, Directive 9200.4-17*****, December 1, 1997.**

- **Clarifies EPA's position on use of monitored natural attenuation (MNA) for remediating contaminated sites.**
- **Not intended to be a detailed technical guidance.**
- **Does not deal with legal or administrative issues (e.g., property transfer, NPL deletion).**

## How To Obtain Directive

- **RCRA, Superfund Hotline: 1-800-424-9346**
- **OUST Home Page**
  - **More Information**
  - **Policy Directive**
  - **http://www.epa.gov/swerust1/directiv/9200_417.htm**

## EPA Definition

- **Monitored Natural Attenuation (MNA):**

***. . . the use of natural attenuation processes within the context of a carefully controlled and monitored site cleanup approach that will reduce contaminant concentrations to levels that are protective of human health and the environment within a reasonable time frame.***

## MNA Processes

- **Physical, chemical, or biological processes that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants.**
- **Includes biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization or destruction of contaminants.**

## MNA Processes *(cont'd)*

- **EPA prefers those processes that degrade contaminants and expects that MNA will be most appropriate where plumes are stable.**
- **Some processes have undesirable results, such as:**
  - **Creation of toxic daughter products, or**
  - **Transfer of contaminants to other media.**

## Role of MNA in OSWER Remediation Programs

- **ALL remedies must protect human health and the environment.**
- **NOT a "walk away" or "do nothing" option.**
- **NOT a "default" or presumptive remedy.**

## Role of MNA in OSWER Remediation Programs *(cont'd)*

- **Site-specific, risk-based decisions are essential. MNA is an active choice although it is a passive remediation technology.**
- **Proponent must demonstrate that MNA is the appropriate option, not the implementing agency.**

## Demonstrating the Efficacy of MNA

- **Three types of site-specific information may be required:**
  1. **Historical ground water and/or soil chemistry data demonstrates trend of declining contaminant concentration.**
  2. **Hydrogeologic and geochemical data that demonstrate NA processes and rates.**
  3. **Field or microcosm studies.**
- **Unless #1 is of sufficient quality and duration, #2 is generally required (regulatory decision).**

## Sites Where MNA May Be Appropriate

- **MNA is appropriate as remedial approach only where it:**
  - **Can be demonstrated to achieve remedial objectives within reasonable time frame, and**
  - **Meets the applicable remedy selection criteria for the particular OSWER program.**

## Sites Where MNA May Be Appropriate *(cont'd)*

- **MNA will typically be used in conjunction with active remediation measures (e.g., source control) or as follow-up to such measures.**
- **MNA should not be used where such an approach would result in significant contaminant migration or unacceptable impacts to receptors.**

## Reasonable Time Frame

- **Time frame should not be excessive compared to that required for other remedies.**
- **Reasonable time frame is a site-specific decision.**

## Reasonable Time Frame *(cont'd)*

- **Some factors that impact "reasonableness" of time frame include:**
  - **Current and potential future uses of affected ground water,**
  - **Relative time frame in which aquifer may be needed,**
  - **Public acceptance of extended time for remediation,**
  - **Reliability of monitoring and institutional controls, adequate funding over time required to reach cleanup objectives.**
  - **Regional resource issues**

## Remediation of Sources

- **EPA expects that source control measures will be evaluated for all sites and implemented at most sites where practicable.**
- **Measures include removal, treatment or containment of sources.**
- **Source control is especially important where MNA is part of the remedy.**
- **Appropriate source control actions are high priority and should be implemented sooner rather than later in site response.**

## Performance Monitoring

- **Required to gauge effectiveness and protect human health and the environment.**
- **Of even greater importance for MNA remedies because longer cleanup time frames are generally involved.**
- **Must demonstrate that NA is occurring as expected, identify transformation products, detect plume migration, and verify no impact to receptors.**
- **Required for as long as contamination levels remain above cleanup goals.**

## Contingency Remedies

- **A cleanup technology or approach that will function as a "backup" in the event that MNA fails to perform as anticipated.**
- **Contingency measures are especially important when MNA is selected based primarily on predictive analysis (i.e., uncertainty is greater than when based on historical data).**
- **"Triggers" should be established which signal unacceptable performance of the MNA remedy.**

## Summary

- **MNA is appropriate at many but NOT all sites.**
- **NOT a "no action," "default" or "presumptive" remedy.**
- **Should NOT result in significant contaminant migration or unacceptable impacts to receptors.**

## Summary *(cont'd)*

- **Progress should be carefully monitored.**
- **Contingency measures should be included when selection of MNA was based mostly on predictive analysis.**
- **A cleanup is NOT completed until cleanup objectives, set by the implementing Agency, have been met.**

## Where to Find the OSWER MNA Directive and Technical Updates

- **http://www.epa.gov/swerust1/directiv/9200_417.htm**
- **http://www.epa.gov/ORD/WebPubs/biorem (case sensitive)**

# Trends in the Use of Monitored Natural Attenuation

**This page has been left blank intentionally for printing purposes.**

# Trends in the Use of MNA

**Fran Kremer**
**US EPA**
**Office of Research and Development**
**National Risk Management Research Lab**
**Cincinnati, OH**

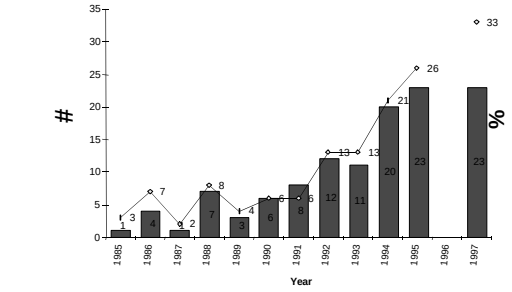
## Programs that May Look at Natural Attenuation in Cleanup

- **UST**
- **CERCLA**
- **RCRA**
- **State Voluntary Cleanup Programs**
- **Brownfields Sites**

## How Has Natural Attenuation Been Used?

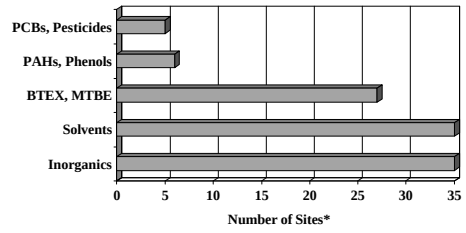
- **Variety of sites, including MLFs, industrial LFs, refineries, recyclers, etc.**
- **At all but six sites, natural attenuation used in combination with active remedy components**
- **Often have low exceedences of cleanup levels**
- **Contingencies for active measures**

## MNA Groundwater RODs



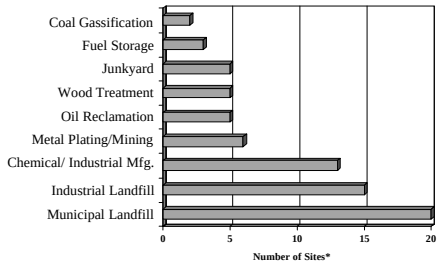

Office of Solid Waste and Emergency Response

## Contaminants Present at Sites for which Natural Attenuation was Specified



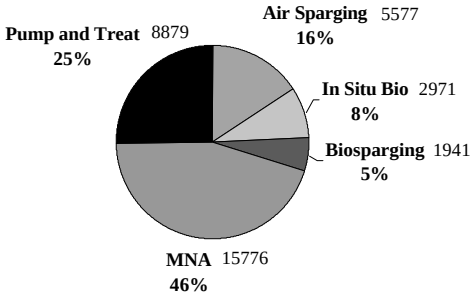

*Some sites have more than one contaminant

## Contaminants Present at Sites for which Natural Attenuation was Specified

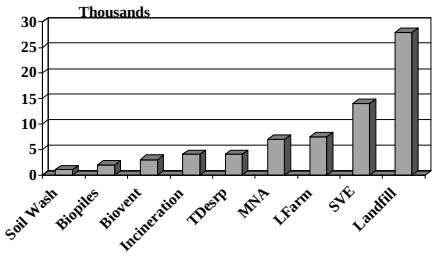



*Some sites have more than one contaminant

## LUST Groundwater Remediation Technologies, FY97




## Soil Remediation Technologies at UST Sites, FY97



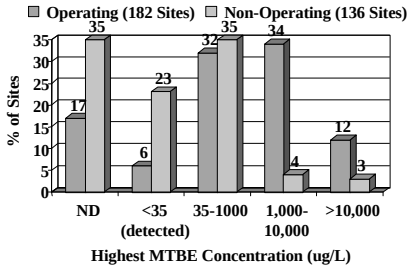

Office of Underground Storage Tanks, 1998

## Occurrence of MTBE by Geographical Area

- **Maximum MTBE Concentrations Exceed 1mg/L at:**
  - **47% of 251 California sites**
  - **63% of 153 Texas sites**
  - **81% of 41 Maryland sites**

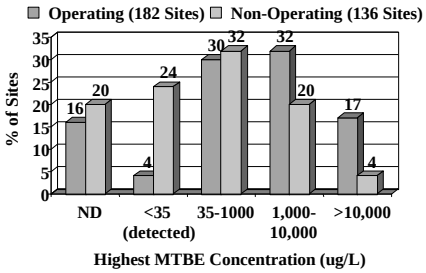
*T. Buscheck, et al.*

## MTBE Occurrence at Northern California Sites



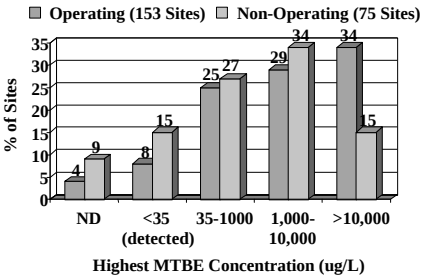

*T. Buscheck, et al.*

## MTBE Occurrence at Southern California Sites



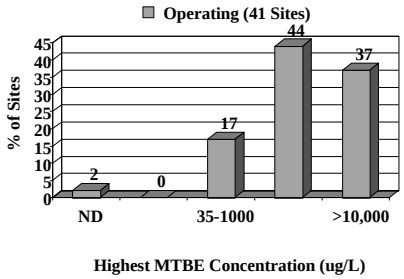

*T. Buscheck, et al.*

## MTBE Occurrence at Texas Sites



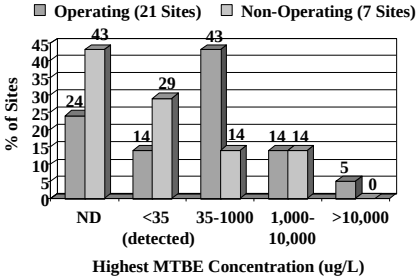

*T. Buscheck, et al.*

## MTBE Occurrence at Maryland Operating Sites




*T. Buscheck, et al.*

## MTBE Occurrence at Florida Sites




*T. Buscheck, et al.*

**This page has been left blank intentionally for printing purposes.**

# Framework for Use of Monitored Natural Attenuation

**This page has been left blank intentionally for printing purposes.**

# Framework for Use of MNA

**Fran Kremer**
**US EPA**
**Office of Research and Development**
**National Risk Management Research Lab**
**Cincinnati, OH**

## Potential Advantages of MNA

- Generation of lesser volume of remediation wastes, reduced potential for cross-media transfer of contaminants, & reduced risk of human exposure to contaminated media
- Less intrusion
- Potential for application to all or part of given site

## Potential Advantages of MNA

- Use in conjunction with, or as a follow up to, other (active) remedial measures
- Lower overall remediation costs than those associated with active remediation

## Potential Disadvantages of MNA

- Longer time frame may be required to achieve remediation objectives
- Site characterization may be more complex and costly
- Toxicity of transformation products may exceed that of the parent compound
- Long term monitoring

## Potential Disadvantages of MNA

- Institutional controls may be necessary to ensure long-term productiveness
- Potential for contaminant migration
- Possible renewed mobility of previously stabilized contaminants
- More extensive education and outreach efforts

## Two Basic Questions for Bioremediation

- When to start?
- When to stop?

## When to Stop Active Remedial Processes

- When active treatment no longer doing any good
- When active treatment is no faster than MNA

## Contaminant Releases

- Migrate from source area
- Area of contamination expands until equilibrium reached
- MNA equals source output

## When/Where is Equilibrium Reached?

- Site factors- soil type, precipitation influx
- Contaminant factors- solubility, concentration, carrier...

## Equilibrium

- Eventually, MNA exceeds rate of source output, and concentration of contaminant(s) stabilizes or decreases
- Importance of source control as the primary remedial alternative

## Source Control

- "Source control actions should use treatment to address "principal threat" wastes (or products) wherever practicable, and engineering controls such as containment for waste (or products) that pose a relatively low long-term threat or where treatment is impracticable"

## Monitoring Strategies

- Three kinds of monitoring
  - 1. Site characterization to describe disposition of contamination and forecast its future behavior.
  - 2. Validation monitoring to determine whether the predictions of site characterization are accurate.
  - 3. Long-term monitoring to ensure that the behavior of the contaminant plume does not change

## Developing Conceptual Model

- Determine nature and 3-D extent of contamination
- Determine site processes mobilizing contaminants
- Determine factors influencing contaminant movement pathways
- Determine changes in contaminant location and concentration with time
- Determine the point(s) of attainment

## Determine Nature and 3-D Extent of Contamination

- Contaminants
- Contaminant properties
  - P/C-solubility, volatility, Henry's Law, sorption coefficients, pH
  - Bio-degradation potential, required redox, electron acceptors/donors, by-products

## Determine Nature and 3D...(cont)

- Contaminant location- where are they, how far have they moved, define in 3-D
- Contaminant concentration
- Contaminant form/phase-solid, NAPL, vapor, adsorbed, dissolved

## Determine Processes Mobilizing Contaminants

- Volatilization
- Leaching
- Mobile NAPL-gravity, water table fluctuations, GW flow
- Dissolution in GW

## Determine Factors Influencing Contaminant Movement Pathways

- Lithology
- Hydrogeology-flow rates, flow paths, gradients

## Determine Changes in Contaminant Location and Concentration with Time

- Soil concentrations
- NAPL movement
- Changes in dissolved fraction
- Seasonal fluctuations

## Points of Attainment

- **Given 3-D extent of contamination, will natural attenuation be protective?**
- **Develop model**

## Predictive Models

- **Use of site specific data to predict the fate and transport of solutes, given the controlling physical, chemical and biological processes**
- **Results of the modeling only as good as the data input**
- **Several solute fate and transport models available**

## How to Improve Understanding & Implementation of MNA

- **Control/treat/remove sources**
- **Thoroughly monitor plume and downgradient areas**
- **Include contingencies for other measures if MNA fails to meet desired goals**
- **Involve regulatory agencies early in process**

## How to Improve Understanding & Implementation of MNA

- **Communicate that MNA is a responsible, managed remediation approach(not a walk away)**
- **Present site-specific data and analysis that demonstrate occurrence**
- **Develop defensible conceptual model supporting MNA**
- **Build defensible predictive models, where appropriate**

## Natural Attenuation

- **Burden of proof is on the proponent, not the regulator**
- **Not a default technology or presumptive remedy**
- **Not complete until goals of the regulatory agency have been reached to their satisfaction**